ABSTRACTS OF MEMOIRS

RECORDING WORK DONE AT THE PLYMOUTH LABORATORY

CHANDLER, W. K. & HODGKIN, A. L., 1965. The effect of internal sodium on the action potential in the presence of different internal anions. *J. Physiol., Lond.*, Vol. 181, pp. 594–611.

Action potentials and resting potentials were recorded from squid axons perfused with solutions containing fluoride or glutamate as the main anion.

Provided that a low impedance electrode with an axial wire was employed, the overshoot never exceeded the sodium equilibrium potential, and varied with internal sodium in a manner consistent with the sodium hypothesis.

A possible source of error in recording action potentials with a high-impedance electrode is described.

AUTHORS' SUMMARY

CHANDLER, W. K., HODGKIN, A. L. & MEVES, H., 1965. The effect of changing the internal solution on sodium inactivation and related phenomena in giant axons. *J. Physiol., Lond.*, Vol. 180, pp. 821–36.

The effect of internal solutions on steady-state sodium inactivation was investigated on perfused axons using the voltage clamp method.

Dilution of the internal KCl solution with isotonic sucrose shifted the inactivation curve along the voltage axis in the positive direction. The shift did not occur when KCl was replaced by NaCl, choline chloride or RbCl at constant ionic strength.

It is concluded that the position of the inactivation curve is determined by the ionic strength of the internal solution rather than by the potassium concentration.

Additional experiments showed that the kinetics of inactivation in perfused axons were similar to the kinetics in intact axons.

Measurements of the time course of the inactivation indicated that the inactivation follows an approximately exponential time course from the beginning of a depolarizing pulse.

AUTHORS' SUMMARY

CHANDLER, W. K. & MEVES, H., 1965. Voltage clamp experiments on internally perfused giant axons. *J. Physiol., Lond.*, Vol. 180, pp. 788–820.

1. Voltage clamp experiments were carried out on internally perfused giant axons.

2. Early outward currents were observed with large depolarizations with KCl + sucrose (no Na) inside the fibre and either sodium or choline artificial sea water outside. These currents were similar to those generally associated with movement of Na ions. They were decreased when the internal KCl was replaced with RbCl, CsCl or sucrose.

3. The early outward current was turned on and was inactivated in a manner quantitatively similar to that for the early sodium conductance.

4. It is concluded that potassium can go through the sodium channel but much less readily than sodium.

5. The relative Na:K selectivity was not changed by lowering internal pH, by replacing chloride with sulphate or by deterioration; the selectivity appeared to be lowered by diluting the internal KCl with sucrose.

6. Replacement of internal KCl with NaCl changed the equilibrium potential of the early current in a manner consistent with a sodium electrode of selectivity $P_{Na}/P_K = 12$.

7. Equilibrium potentials were measured with external lithium and with internal rubidium and caesium; the selectivity to cations followed the sequence Li > Na > K > Rb > Cs. On the assumption that only monovalent cations go through the sodium channel the relative permeabilities of Li:Na:K:Rb:Cs were 1·1:1:1/12:1/40:1/61.

8. Replacement of internal potassium with either choline, sodium, rubidium or caesium decreased the late currents below the values expected from the independence principle.

AUTHORS' SUMMARY

CHAPMAN, D. M., 1965. Co-ordination in a Scyphistoma. *Am. Zoologist*, Vol. 5, pp. 455–64.

The scyphistoma of *Aurelia aurita* was stimulated electrically and mechanically in various well-defined regions. Each of these regions is neurologically independent in that the effects of the stimulation are localized to just one region of the polyp. Co-ordination of the different regions during prey capture and ingestion is still possible, however, because of the arrangement of the parts of the polyp in which one action sets off another one mechanically. The polypoid form of the scyphistoma is a geometrical arrangement allowing mechanical co-ordination. Such a co-ordination mechanism would not be suitable for the life of a medusa whose complicated problems necessitate neurological connexions between the body regions for their co-ordination. On the principle that simple organisms arose first during evolution, it is maintained that the polypoid preceded the medusoid form in the Class Scyphozoa. Of the three polypoid types, viz. hydropolyp, scyphopolyp and anthopolyp, the scyphopolyp has the simplest neuromuscular system and behaviour.

AUTHOR'S SUMMARY

HUGHES, G. M. & BALLINTIJN, C. M., 1965. The muscular basis of the respiratory pumps in the dogfish (*Scyliorhinus canicula*). *J. exp. Biol.*, Vol. 43, pp. 363–83.

A study has been made of the muscular basis of the respiratory pumps of the dogfish by recording simultaneously electromyograms, pressures and movements in the branchial region. Electrical activity in most of the muscles occurs more or less synchronously during the phase when the oro-branchial and parabranchial cavities are decreasing in volume. The adductor mandibulae, however, also shows tonic activity during expansion of the branchial region. During quiet ventilation movements no electrical activity was recorded in the hypobranchial musculature. But the coracomandibularis and other hypobranchial muscles become active during hyperventilation and also when the pharyngeal region is widely expanded before biting.

It is concluded that ventilation is primarily achieved by contraction of the superficial constrictor muscles, which produces an increase in pressure in the oro-branchial and parabranchial cavities. Water is forced through the gills because the pressure in the oro-branchial cavity exceeds that in the parabranchial cavities during both this phase and the expansion phase which succeeds it. Expansion of the branchial region occurs when the constrictor muscles relax, and is mainly due to the elasticity of the branchial basket and associated connective tissues. This expansion is aided by the tonic activity of the adductor mandibulae.

During swimming of certain sharks, the whole branchial region remains in a relaxed condition and water enters the mouth. The volume entering at any one time could be regulated by variations in the tonic activity of the adductor mandibulae.

It is suggested that the lateral plate muscles are of primary importance in ventilation and that only later in the evolution of fishes does the myotomic component of the head musculature become concerned with respiration. G.M.H.

HUGHES, G. M. & GRIMSTONE, A. V., 1965. The fine structure of the secondary lamellae of the gills of *Gadus pollachius*. *Q. Jl microsc. Sci.*, Vol. 106, pp. 343–53.

An electron-microscope study of sectioned material of the secondary lamellae has been made, particularly in relation to their function in gas exchange. The epithelial layers on the two sides of the secondary lamellae are supported by widely spaced pillar cells. Each epithelium is one or more cells thick and consists of cells with large nuclei, abundant mitochondria and cytoplasmic membranes. Their structure is relatively complex if they form only a diffusion barrier, and suggests the presence of some more active process.

The pillar cells have a central cell body with wide flanges at each end which spread out below the epithelia. Flanges of adjacent cells meet and connect and so delimit the extensive blood space between the pillar-cell bodies. Pillar cells contain abundant mitochondria and membranes and their cytoplasmic matrix is largely occupied by finely fibrous material. They appear to be responsible for the formation of a collagen-containing basement membrane which lies between them and the overlying epithelia. There are also columns of basement membrane material set in deep infoldings of the surface of the pillar-cell bodies.

The water/blood pathway across which gaseous exchange takes place consists of the epithelium, basement membrane and pillar cell flange and has a total thickness of 1–3 μ. G.M.H.

SHAW, T. I., 1966. Cation movements in perfused giant axons. *J. Physiol., Lond.*, Vol. 182, pp. 209–16.

The net movements of Na and K into resting squid giant axons perfused with a K_2SO_4 artificial axoplasm have been determined. Na enters at a rate of 131 ± 25 p-mole/cm^2.sec. The K leakage from the fibre is 942 ± 566 p-mole/cm^2.sec; clearly this latter figure shows how large is the uncertainty in the exact value for the potassium leakage.

The net entry of sodium associated with activity in such fibres has been measured and is $5{\cdot}7 \pm 0{\cdot}7$ p-mole/cm^2.impulse. T.I.S.